

# Engineering company improves project efficiency across the globe with Maplesoft calculation tools

*This case study illustrates how international multi-service engineering companies use Maplesoft technology to overcome business challenges arising from the use of unstructured standard calculation methods and tools. Although the details have been changed and a pseudonym used to describe the company, the scenarios depicted are entirely consistent with how Maplesoft products are used.*

## CHALLENGES FACED

Global Engineering Company (GEC), a global multi-services engineering company with 10,000 employees, has many major infrastructure projects around the world, including power, roads, railways, municipal infrastructure, and marine. They employ many different types of engineers across their international divisions, including civil engineers, mechanical engineers, electrical engineers, and others. Because of the diverse nature of the projects, differing backgrounds of the staff, and the need for international collaboration, GEC faced many business challenges arising from the use of unstructured standard calculation methods and tools, including:

- **Inefficient spreadsheets and handwritten calculation sheets**
  - Poorly documented calculations
  - Engineering context is buried and hidden
  - Mistakes are easy to introduce and difficult to track down
  - Calculations are not easily understood, extensible or shared
- **International workforce with little standardization**
  - Lack of standardized calculation methods make it difficult for engineers from different international offices to collaborate on analyses
  - Misunderstandings reduce efficiency and introduce project risk
- **Engineers retiring or changing jobs**
  - The knowledge and skills of experienced engineers are lost when they leave
- **Different groups of engineers and different projects with different mathematical requirements**
  - Engineers cannot always choose the optimal tool for each project, as they sometimes must use a tool previously selected with different needs in mind
  - Licensing different tools from different vendors to satisfy different needs is inefficient in terms of time, money, and management overhead.

## PATH TO TRANSFORMATION

After assessing several vendors, GEC chose a collection of interoperable math tools and training/consultancy services from Maplesoft. The tools:

- **Help design engineers** do calculations, create reports, and amplify their ability for exploratory data analysis
- **Enable research engineers** to develop models with symbolic math, numerical computation, and algorithm design

In addition, the global licensing scheme offered by Maplesoft is cost-effective and lets engineers swap between different Maplesoft tools, depending on their needs and projects. Engineers can use licenses from a network installation for short term projects, or clusters of licenses can be moved from one server to another.

This case study explores some of the different ways GEC now uses Maplesoft technology across their diverse international groups.

## STRUCTURAL ANALYSIS GROUP IN THE UNITED KINGDOM

The drive to nuclear power to minimize Europe's dependence on natural gas has meant a UK-based structural group at GEC is now involved in long term nuclear projects that have a lifetime of 20-30 years.



Their previous calculation tool was Excel®. When Excel was in use, calculations had to be manually transcribed from Excel into Microsoft® Word to create reports, which was a cumbersome and error-prone process. If the parameters changed, engineers had to re-transcribe their results to update the report.

The team now uses Maple Flow™ for readable calculation reports with built in analyses involving structural concrete design that follows internationally recognized codes. They created a reusable library of section properties to assist their analyses. No manual transcription is required.



Because of the highly regulated nature of the work, calculations must be auditable and traceable for the length of the project (20 to 30 years). The Maple Flow documents combine calculations, visualizations, text, and images into a single document, so the engineering reasoning behind the calculations is clearly communicated, reducing the risk that knowledge will be lost when an engineer leaves the project. When a parameter is changed, all results are automatically updated in the document so there is no longer a need to manually update a separate calculation report. Some of their reports are more than 30 pages long and, in the past, have been time consuming to produce and keep up to date, but Maple Flow has reduced the time taken to prepare a calculation report by 75%.

Maple Flow is built on the world's most powerful math engine, but it is also simple enough to be used in GEC's civil design apprenticeship training program. Design apprentices are students who perform simple analysis tasks, such as calculating beam loads to European standards. Additionally, senior engineers can more easily check their work now that it is done in Maple Flow.



## BRIDGE DESIGN GROUP IN CHINA

A Chinese bridge design group was using Excel for their design calculations, with a typical application being the design of a bridge deck girder. But Excel spreadsheets are difficult to debug and share, so the group opted to move their design calculations to Maple Flow. This change eliminated calculation errors entirely, as well as completely eliminating the manual process of transcribing calculations from Excel to Word for documentation. As a result, they increased the reliability of their calculations, and reduced calculation errors by 20%.

This group was trained by Maplesoft's China-based engineers. During the training, they learned how to implement the dimensionally-inconsistent empirical equations from standard design codes in a dimensionally-aware environment, taking advantage of built-in support for units in Maple Flow.



## HYDROLOGY ENGINEER IN THE UNITED STATES

A river engineer located at the GEC headquarters in the United States needed hydrology calculators that could be accessed from anywhere, including out in the field. This engineer developed interactive calculators in Maple™ by making use of both its mathematical engine and its environment for easily creating point-and-click style mathematical applications. Once completed, the hydrology calculators were deployed over the web via MapleNet™. As a result, these hydrology calculators are accessible from a web browser by any GEC employee who needs them, and they are very easy to use, even by people who have no experience with calculation software.

## Testimonials:

*"Maple's computational capabilities are unmatched... even complex matrix manipulations are easily processed by Maple. I am very pleased with the results we obtain using Maple."*

- Dr. Daniel Morales, Research Manager for Control Systems at Hiab

*"Maple Flow is the back of napkin calculation for the 21st century."*

-Tom Spendlove, Mechanical Engineer and Assistant Professor of Practice, School of Engineering, Western Carolina University

*"Our spreadsheets can be unnecessarily complicated, and over the years, we've seen them grow into something very big and clunky. Maple just made it easier – calculations we used to do in previous tools can be done in Maple using only a few lines."*

-Yuri Kinakin, Superintendent of Process Technology at Diavik Diamond Mine, a joint venture between Rio Tinto and Dominion Diamond Corporation

*"Using Maple makes calculations more efficient than using spreadsheets. HTM engineers can set up their analysis with an intuitive math input, and use built-in functions to automatically solve and simplify work, reducing many of the possible errors they had associated with traditional, manual effort."*

-Dr. Shen, Senior Manager of the Technical Analysis Group, Hitachi Construction Truck Manufacturing (HTM) Ltd.

*"Using MapleNet, I feel more in control of the data I share. Unlike other tools, MapleNet doesn't need a player, which makes it very easy and convenient to use."*

-Dr. Peter Waegli, Founder of Dr. P. Waegli-Research and Engineering Consultant for Eppstein Technologies

*"The use of Maple to predesign our inspection routines has generated fantastic time and cost savings to our company. The end result was a massive reduction in costly machine downtime: the time required to perform an inspection of a single rotor with 88 blades has been reduced from 7 days to 2 days."*

-Jean Michel Puybouffat, Leader of In-service Inspection Team, Rotek



## RAILWAY ENGINEERING GROUP IN THE UNITED KINGDOM

A team of corrosion engineers located in GEC's UK office analyze corrosion and failure rates of rail tracks. This involves analyzing large amounts of field data (hundreds of thousands of elements) in Maple.

The team's analysis involves plotting, manipulating, and analyzing large data files. Maple ensures that the analysis is fast and memory efficient. In addition, automatic parallelism and multi-process programming tools mean that analyses can be distributed across all the cores of the local computer. Each multi-threaded Maple analysis computes 2 times faster than Excel, and 1.5 times faster than a Python script.

A co-group in the rail division also uses Maple to develop custom algorithms in the Maple language. Some of these algorithms are then exported to the C programming language using code generation tools in Maple, for incorporation into a third-party tool.

## MATHEMATICAL ANALYSIS AND SCIENTIFIC SOFTWARE DEVELOPMENT IN FRANCE

A small group of GEC mathematical research engineers are headquartered in France. This team is regularly presented with complex engineering problems that need a mathematical

solution, and the techniques they employ make use of computer algebra, numeric computation, and visualization.

The group uses Maple Flow to first rough out and then formalize their technical ideas through progressive refinement of their math. Maple Flow supports this commonly used iterative approach to problem solving with its whiteboard-style environment, while also ensuring that the calculations are correct. As a bonus, Maple Flow provides comprehensive visualizations that lead to insights for the next iteration.

## CONCLUSION

GEC has successfully deployed Maplesoft mathematics technology, including Maple Flow, Maple, and MapleNet, across several international divisions. They achieved the efficiency improvements that come from incorporating structured, standardized calculations into their workflows, supported by a versatile toolset that satisfies many needs. They also benefited from the simplicity of working with a single technology vendor with a responsive and experienced engineering consultancy team that will jump in and help whenever they're needed.